The Geotactic Responses of the Land Snail *Helix aspersa* Müller to a Reverse Incline

BY

THOMAS H. IRWIN

Department of Biology, Victor Valley College
Victorville, California 92392

(1 Text figure; 2 Tables)

INTRODUCTION

Several authors of general works on animal behavior and orientation mention research on the geotactic response of various species of terrestrial gastropod mollusks. The species most commonly referred to seem to exhibit a negative taxis against gravity. The pulmonate, *Helix,* was reported to be strongly negatively geotactic, especially when submerged in water (Fraenkel & Gunn, 1961). The tree snail, *Liguus,* was observed also to be strongly negatively geotactic to steep angles where the shell of the snail was pulled from its normal position (Carthy, 1958).

In a recent paper on the orientation of *Helix aspersa* Müller, 1774 (Bower, 1962), results indicated that this snail was very sensitive to a slight angle of only 15 degrees. The degree of accuracy of the snail's negative geotactic orientation remained fairly constant as the angle of inclination was increased in steps from the horizontal to 90 degrees.

It would be of considerable interest, particularly from the point of view of an orientation mechanism within the snail, to extend the experiment performed by Bower to include angles of more than 90 degrees. Thus, to exhibit their negative geotactic response, the snails would have to climb an incline upside down. This would place the snail's shell and statoliths in a different position, with relation to the body, than on a standard incline.

METHODS

The same general methods as described by Bower (1962) were followed. An adjustable inclined plane was constructed so that any desired angle of inclination could be achieved. Large sheets of art paper were fixed to the incline. The snails (*Helix aspersa*) were allowed to adhere to the paper facing in various directions while the plane was set at 180° (horizontal). A thin ring of sodium fluorescein (water soluble uranine) was placed around the snails to provide a visible trail as they moved. The plane was then set in the desired incline. Ten snails were used for each trial so that traffic on the incline would not be

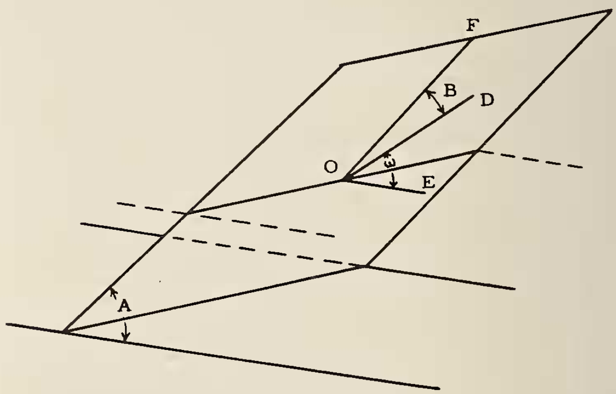

Figure 1

Reverse Incline Apparatus modified from Bower (1962)

A = Angle of inclination

B = Angle deviation (mean for group)

ω = Angle between the snail's true path of orientation and the horizontal

O – D = Path of snail

O – E = Path of snail projected onto horizontal surface

O – F = Line of the surface perpendicular to the horizontal when the surface incline is 90°

congested. After each trial the paper runway was replaced. Two trials at each angle were conducted on different days in total darkness, and the results were averaged. Each group of snails was given 15 minutes to move 10 cm. This was found to be adequate time for most. Those not moving the required distance were eliminated from the experiment. The angle of deviation from an expected straight line path up the incline was figured for each snail completing a 10 cm move. These angles were then averaged and used as an index of the snail's ability to respond to a given angle of inclination. Geotactic accuracy was calculated using the same methods as described by Bower (Figure 1). Geotactic accuracy was determined by the equation:

$A-\omega$ = degree of accuracy
A = the angle of inclination of the surface
ω = the angle between the snail's true orientation path and the horizontal. ω, in turn, was derived by the equation: $\sin\omega = \sin A \cos B$, where B is the mean of the angular deviations.

RESULTS

The results of Bower's work with a standard incline are shown in Table I. Table II shows the results using a reverse incline.

Table 1

Summary of the Results of Bower (1962) Showing the Degree of Accuracy of *Helix aspersa* to a Normal Incline

(A)	MAD	RAD	ω	(A−ω)
0°	Control – Apparent Random Manner			
15°	28° 56′	1 – 57°	13° 10′	1° 50′
30°	20° 56′	1 – 51°	27° 50′	2° 10′
45°	15° 38′	1 – 30°	42° 55′	2° 05′
60°	11° 45′	1 – 27°	57° 59′	2° 01′
75°	7° 41′	1 – 17°	73° 08′	1° 52′
90°	8° 53′	0 – 39°	81° 07′	8° 53′

A = angle of inclination
ω = angle between the snail's true orientation path and the horizontal
$A-\omega$ = degree of accuracy
MAD = mean of angle deviation
RAD = range of angle deviation

Table 2

Results of a Reverse Angular Inclination Where the Snails Must Climb the Incline Upside Down
(See explanation in Table I)

(A)	MAD	RAD	ω	(A−ω)
0°	Control – Apparently Unoriented			
15°	15° 54′	2 – 33°	14° 25′	0° 35′
30°	6° 48′	1 – 16°	29° 46′	0° 14′
45°	14° 12′	2 – 30°	43° 16′	1° 44′
60°	7° 28′	2 – 12°	59° 10′	0° 50′
75°	5° 42′	0 – 20°	74° 10′	0° 50′
90°	4° 12′	0 – 8°	85° 48′	4° 12′

DISCUSSION

A comparison between Table I and Table II shows a similar degree of accuracy in the geotactic orientation of *Helix aspersa*. The data presented indicate that the accuracy of negative geotactic response of this snail is similar whether it is climbing an incline in an upright position or in a reversed, upside-down position. The discrepancies in the tables are most likely a result of the difficulties in accurate angle measurement of the groups of smaller sizes used in this experiment. These discrepancies, however, are slight. Also of some interest might be the small percentage of snails that did not move the required distance in the prescribed time. These snails were eliminated and their movement was not recorded. In each group one or two snails failed to show any response, but it is unlikely that these individuals would affect the data presented.

LITERATURE CITED

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